NASA Giovanni: A Tool for Visualizing, Analyzing, and Inter-comparing Soil Moisture Data

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Introduction

There are many existing satellite soil moisture algorithms and their derived data products, but there is no simple way for a user to inter-compare the products or analyze them together with other related data (e.g., precipitation). An environment that facilitates such inter-comparison and analysis would be useful for validation of satellite soil moisture retrievals against in situ data and for determining the relationships between different soil moisture products. The latter relationships are particularly important for applications users, for whom the continuity of soil moisture data, from whatever source, is critical. A recent example was provided by the sudden demise of EOS Aqua AMSR-E and the end of its soil moisture data production, as well as the end of other soil moisture products that had used the AMSR-E brightness temperature data. The purpose of the current effort is to create an environment, as part of the NASA Giovanni family of portals, that facilitates inter-comparisons of soil moisture algorithms and their derived data products.

Soil Moisture and Related Data

The following are some soil moisture and related data products that are included in a beta prototype of a Giovanni portal ("Inter-comparison of Soil Moisture Products"). This suite of products will be added to or modified, based on user feedback and availability of resources. The current three soil moisture products are part of two NASA ROSES-funded projects, with end user project team members from NOAA National Weather Service (NWS) and USDA World Agricultural Outlook Board (WAOB).

EOS Aqua AMSR-E (Advanced Microwave Scanning Radiometer for EOS) AE_Land3

- Surface soil moisture
- Daily, 25-km, global; June 2002 to October 3, 2011 (when sensor failed)
- Archive: National Snow and Ice Data Center (NSIDC)
- Njoku et al., 2003. Soil moisture retrieval from AMSR-E, *IEEE Trans. Geoscience and Remote Sensing, 41*(2), 215–229.

LSMEM (Land Surface Microwave Emission Model) TMI (TRMM Microwave Imager)/TRMM

- Surface soil moisture
- Daily, ¼°, U.S. up to 40°; January 1998 to December 2004
- Archive: Princeton University (and GES DISC)
- Ongoing MEaSUREs project will produce global (+/- 40°) LSMEM-TMI and global LSMEM-AMSR-E products.
- Gao et al., 2006. Using TRMM/TMI to retrieve soil moisture over the southern United States from 1998–2002, *J. Hydrometeorology*, *7*, 23-38.

LPRM (Land Parameter Retrieval Model) AMSR-E/Aqua

- Surface soil moisture, skin temperature, optical depth
- Daily, ¼°, global; June 2002 to October 3, 2011 (when sensor failed)
- Archive: GES DISC (and Vrije Universiteit Amsterdam)
- Owe et al., 2008. Multisensor historical climatology of satellite-derived global land surface moisture, *J. Geophys. Res., 113,* F01002, doi:10.1029/2007JF000769.
- De Jeu et al., 2008. Global soil moisture patterns observed by space borne microwave radiometers and scatterometers, *Surveys in Geophysics, 29*(4-5):399-420, doi:10.1007/s10712-008-9044-0.

Related Data Sets

EOS Aqua AIRS (Atmospheric Infrared Sounder) AIRX3STD

- Surface air temperature
- Daily, 1°, global; August 2002 to current
- Archive: GES DISC
- Aumann et al., 2003. AIRS/AMSU/HSB on the Aqua mission: design, science objectives, data products, and processing systems. *Geoscience and Remote Sensing, IEEE Transactions on, 41,* 253-264.

TRMM (Tropical Rainfall Measuring Mission) 3B42 daily

- Precipitation
- Daily, ¼°, global +/- 40°; January 1998 to June 2011 (soon to current)
- Archive: GES DISC
- Huffman et al., 2007. The TRMM Multisatellite Precipitation Analysis (TMPA): Quasi-Global, Multiyear, Combined-Sensor Precipitation Estimates at Fine Scales. *Journal of Hydrometeorology, 8,* 38-55.

Giovanni

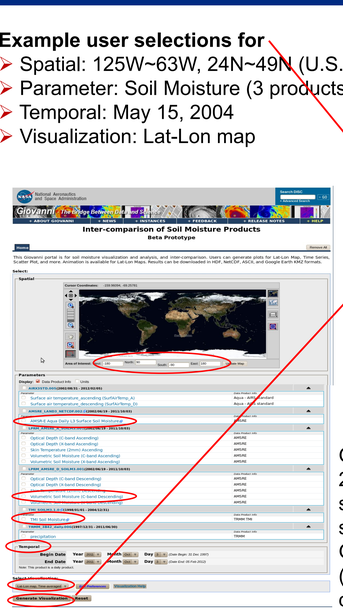
Giovanni (http://disc.sci.gsfc.nasa.gov/giovanni/overview/index.html) is a NASA data analysis and visualization system that provides a simple and intuitive way to visualize, analyze, and access vast amounts of Earth science remote sensing data, without having to download the data (Acker and Leptoukh, 2007; Berrick et al., 2009). It is an online application that allows researchers to rapidly explore data, so that spatial-temporal variability, anomalous conditions, and patterns of interest can be directly analyzed online before optional downloading of data. Giovanni has contributed to many users' science research efforts and applications (http://disc.sci.gsfc.nasa.gov/giovanni/additional/publications).

- Acker, J. and G. Leptoukh, 2007. Online analysis enhances use of NASA Earth science data, *EOS, Trans. Amer. Geophysical Union, 88,* 14.
- Berrick, S., G. Leptoukh, J. Farley, and H. Rui, 2009. Giovanni: A Web services workflow-based data visualization and analysis system. *IEEE Trans. Geosci. Remote Sens.*, *47*(1), 106-113.

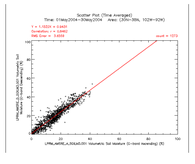
Giovanni Inter-comparison of Soil Moisture Portal (Beta Prototype)

Example user selections for

- Spatial: 125W~63W, 24N~49N (U.S.)
- Parameter: Soil Moisture (3 products)
- Temporal: May 15, 2004
- Visualization: Lat-Lon map

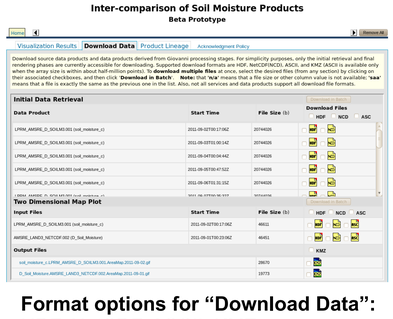


Giovanni GUI interface (left). Lat-Lon maps, May 15, 2004 (above left) of 3 soil moisture products. Time series, May 1 - August 31, 2004 (above right) of same 3 products, covering parts of U.S. Southern Great Plains (SGP). Scatterplot, May 1-31, 2004 (below) of LPRM soil moisture (day and night), covering parts of SGP.

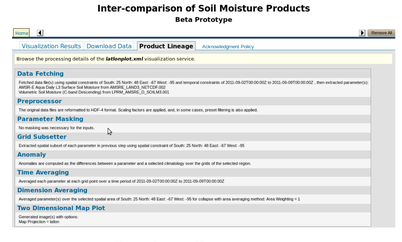


Currently available visualization types:

- Lat-Lon map,Time-averaged
- Time series
- Animation

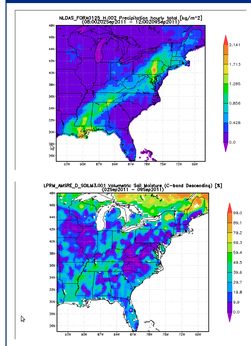


Format options for "Download Data":
HDF, NetCDF, ASCII, KMZ

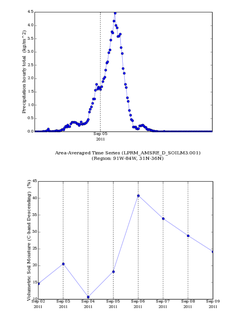


Product lineage

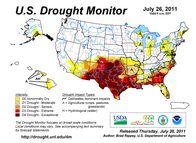
Applications

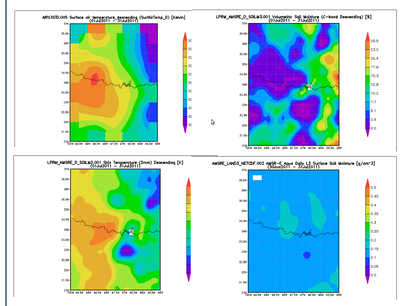


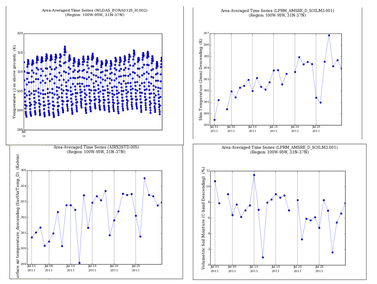
Tropical storm (TS) Lee (Sep. 2011), due to its large size and slow forward movement, dumped heavy rainfall over southern Louisiana, Mississippi, Alabama, and the Florida panhandle. Lat-Lon map of North American Land Data Assimilation System (NLDAS) average hourly precipitation (left top) shows Lee's track. LPRM average soil moisture is shown at left bottom. Corresponding time series of precipitation and soil moisture are shown on the right (top and bottom, respectively).



Drought and excessive heat in 2011 created major impacts across the U.S. Southern Great Plains, especially Texas and Oklahoma, as shown by the Drought Monitor map of July 26, 2011 (right). Total direct losses to crops, livestock, and timber in these areas approached $10 billion.



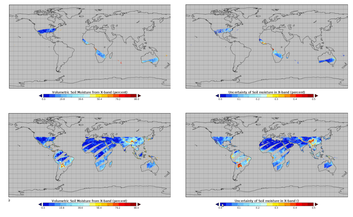




Above left are Lat-Lon maps of the affected areas, averaged over July 1-31, of EOS Aqua AIRS surface air temperature (Tsurf), LPRM skin temperature (Ts), LPRM soil moisture (sm), and EOS Aqua AMSR-E sm Above right are time series (area-averaged) of NLDAS temperature, EOS Aqua AIRS Tsurf, LPRM Ts, and LPRM sm.

Continuity of Data

Maintaining continuity of data and minimizing data gaps are important to both research and applications users of satellite mission data. To mitigate the loss of EOS Aqua AMSR-E and keep the data gap to a minimum, the GES DISC and Vrije Universiteit Amsterdam are producing a LPRM-TRMM Microwave Imager (TMI) product (Levels 2 and 3), to be released ~spring 2012 (examples shown on right). An LPRM-Windsat product may follow, resources permitting. The planned launch of Japan Aerospace Exploration Agency (JAXA)'s AMSR2 is much anticipated.



Seeking User Inputs

The Giovanni Soil Moisture portal, currently a beta prototype, is expected to be a versatile tool, with many possible uses, for research and applications. It should also prove useful for pre-launch SMAP activities (e.g., "Early Adopters" program). To best achieve this goal, we are seeking user inputs on functions, data, and GUI interface. Currently on the list of products to be added are NLDAS and GLDAS data sets.

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